

CHAPTER 3 2,3,7,8-TCDD EQUIVALENTS

I. PRESENT STATE POLICY

Amendments to the Ocean Plan, adopted by the SWRCB under Resolution No. 90-27 on March 22, 1990 (SWRCB 1990a), established a water quality objective of 0.0039 picograms per liter (pg/l) for TCDD equivalents. TCDD equivalents are defined as the sum of the concentrations of seven chlorinated dibenzodioxins (2,3,7,8-CDDs) and ten chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their individual toxicity factors.

The SWRCB adopted the Ocean Plan TCDD equivalents water quality objective based on the U.S. EPA criterion for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), a criterion which considers cancer potency, cancer risk level, bioconcentration, and average fish (including shellfish) consumption rates. However, based upon California Department of Health Services recommendation, the Ocean Plan TCDD equivalents objective adjusted the U.S. EPA criterion to reflect California-specific fish consumption rates, and was adopted as TCDD equivalents, which takes into consideration the toxicity of similar, structurally related 2,3,7,8-CDDs and 2,3,7,8-CDFs. The SWRCB was challenged in court on the inclusion of the equivalence factors as part of the water quality objective. The court upheld the SWRCB process to develop the TCDD water quality objective and application of the objective to the equivalents.

While none of the RWQCBs have adopted water quality objectives for TCDD equivalents, the San Francisco Bay RWQCB has included TCDD equivalents as effluent limits in some waste discharge requirements and is monitoring TCDD equivalents in other discharges.

II. ISSUE DESCRIPTION

CDDs and CDFs represent two families of chemicals, chlorodibenzo-*p*-dioxins (dioxins), and chlorodibenzo-*p*-furans (furans), respectively, which, taken together, comprise over 200 closely related compounds. Dioxins and furans generally occur in the environment as mixtures of various congeners; that is, they rarely appear individually. Dioxins and furans containing chlorine at the 2,3,7 and 8 positions are some of the most toxic substances in existence; additionally, they are environmentally persistent, they bioaccumulate, and some are probable human carcinogens. The dioxin compound that is best studied and considered the most toxic is 2,3,7,8-TCDD.

The proposed CTR water quality criteria (freshwater and saltwater) for 2,3,7,8-TCDD are less stringent than the existing Ocean Plan water quality objective for TCDD equivalents for two reasons:

1. One of the bases for criteria development, that is, the fish consumption rate used in calculating the freshwater and saltwater criteria; and

2. U.S. EPA's application of the information, specifically, it did not consider the toxicity of the 2,3,7,8-TCDD congeners.

First, the proposed CTR criteria for all carcinogens, including 2,3,7,8-TCDD, are based on five factors: cancer potency, cancer risk level, bioconcentration factor, average sea food consumption rate, and the average adult weight. Three of the factors, fish consumption rate, cancer risk level, and average adult weight are constant factors; that is, they are the same used for calculation of criteria for any carcinogenic chemical compound. The SWRCB used the U.S. EPA's method to calculate the Ocean Plan water quality objective for TCDD equivalents, using the same constant and variable factors, except for a higher fish consumption rate. To calculate the CTR water quality criteria for dioxin, the U.S. EPA used a fish consumption rate of 6.5 grams per day (g/day) per person, roughly equivalent to one (7 ounce) or two (3.5 ounce) meal(s) a month (U.S. EPA [1991] lists a range of fish consumptions rates from 6.5 g/day to 180 g/day). As noted above under "Present State Policy", the SWRCB, in adopting the Ocean Plan, used the Department of Health Services recommended fish consumption rate of 23 g/day per person. This higher rate still may not be high enough to represent the amount of fish eaten by Californians such as recreational and subsistence level fishermen.

The fish consumption rate is important because (1) it represents a direct route of exposure, particularly for any pollutant that accumulates in fish and shellfish, and (2) food consumption is believed to be the primary route of exposure to dioxin for humans. Fish consumption rates for establishing water quality criteria also take into consideration the amount of pollutants that fish and shellfish are exposed to, the type of fish species, the type of fish tissue, and the tissue lipid content, in addition to the actual consumption rate and pattern. Compared to the Ocean Plan fish consumption rate, the U.S. EPA fish consumption rate results in a more lenient CTR criterion, one that may not adequately protect human health in this State. The arguments regarding fish consumption rates extend to all criteria for bioaccumulative pollutants. (Fish consumption rate is a variable which directly affects protection of human health.) Additional information will be available when the California Office of Environmental Health Hazard Assessment (OEHHA) releases its report reviewing fish consumption rates within the State. Staff understands that the draft report will be available for comment later this year and will consider fish consumption by diverse populations including subsistence fishermen and ethnic groups.

The second issue of concern regarding the CTR criteria is particular to dioxin. The draft CTR proposes to promulgate criteria for only the 2,3,7,8-TCDD congener. However, in the CTR preamble, the U.S. EPA indicates its continued support and approval of the SWRCB's previous adoption of TCDD equivalents in the rescinded ISWP/EBEP. The concept of applying the criterion for the most toxic form of CDD to include less toxic congeners is not new for dioxins and furans. For example, the U.S. EPA criterion for polychlorinated biphenyls (PCBs), a group of 209 different PCB congeners, has been based on commercial mixtures, not on a single PCB compound.

The SWRCB, in adopting the Ocean Plan water quality objective for TCDD equivalents, first

calculated a water quality objective for 2,3,7,8-TCDD, then applied the concept of equivalents, assuming that the toxic equivalent factors (for humans/mammals) would represent the relative potency of the CDDs and CDFs (SWRCB 1990b). The approach remains sound, as it is based upon the molecular structure of the CDDs and CDFs.



Briefly, the presence of chlorine at the 2, 3, 7, and 8 positions on the ring structures is related to the toxicity of these compounds. Seventeen of the CDD and CDF congeners have chlorine at all four of the 2, 3, 7, and 8 positions. These 17 are structurally very similar, and have similar physical and chemical properties (U.S. EPA 1985). The structural similarities of these congeners result in similar health effects (including health effects other than cancer) due, in part, to their ability to bind with the protein, aryl hydrocarbon (Ah) receptor, initiating effects on gene activity at the cellular level. This type of structure-activity relationship is pharmacologically sound, and has been clearly demonstrated for dioxin and dioxin-like compounds (SWRCB 1990b). The North Atlantic Treaty Organization Committee on Challenges of Modern Society used this relationship to establish the International Toxicity Equivalency Factors (TEFs) which standardize estimates of relative toxicity and cancer potency for the CDD and CDF congeners relative to the toxicity of 2,3,7,8-TCDD, the most potent congener.

Research published since SWRCB adoption of the Ocean Plan TCDD equivalents water quality objectives indicates that the basis for the toxicity equivalent factor approach (namely, that the structure-activity relationships may be used to establish relative levels of toxicity and carcinogenicity) remains unchanged. Recent studies of dioxin and dioxin-related compounds (1) indicate additivity of CDD and CDF congeners (Birnbaum et al. 1995, Nagao et al. 1993, Schrenk et al. 1994), (2) confirm the principle of toxicity equivalence factors with refinement of individual factors (Nagao et al. 1993, Rozman et al. 1993), and (3) tend to confirm that dioxin-related compounds are probably human carcinogens.

Further, other dioxin-like compounds, such as bromine substituted congeners (Safe 1990) and co-planar PCBs (Ahlborg et al. 1994, Birnbaum et al. 1995, Safe 1990) also exhibit dioxin-like toxicity.

At a June 1997 meeting held in Stockholm, a World Health Organization (WHO) Working Group on TEFs revised three human/mammalian TEFs. The new TEFs are as follows, by congener: 1,2,3,7,8-pentaCDD, 1.0 (formerly 0.5); octaCDD and octaCDF, 0.0001 for each congener (formerly 0.001). The WHO Working Group also provided a listing of newly-established CDD and CDF TEFs for fish and for birds, in addition to listing TEFs for twelve

"dioxin-like" PCBs in all three categories (humans/mammals, fish, and birds). While the TEF listings have been made public, the WHO draft report supporting the listings is still confidential while it is being reviewed by committee members. In addition, the U.S. EPA currently is reassessing the sources, toxicity, and environmental fate of dioxin.

In a separate activity, the U.S. EPA is proposing to add a chemical category that includes dioxin and 27 dioxin-like compounds to the list of toxic chemicals subject to the reporting requirements under the Emergency Planning and Community Right to Know Act (EPCRA) of 1986 (Federal Register, Vol. 62, No. 88, May 7, 1997, pages 24887-24896). The chemicals include seven CDDs, 10 CDFs, and 11 PCBs. The U.S. EPA also is proposing to modify the existing EPCRA Section 313 listing for PCBs to exclude those PCBs that are included in the proposed dioxin and dioxin-like compounds category. A study of these substances in San Francisco Bay fish (white croaker, striped bass, shiner surf perch, leopard shark, and halibut) has shown that the dioxin-like PCB concentrations are much greater than the concentrations of CDDs and CDFs (San Francisco Bay RWQCB 1995, Contaminant Levels In Fish Tissue From San Francisco Bay, Final Report).

A problem with regulating CDDs and CDFs is that they appear to be ubiquitous, which presents a challenge to those responsible for controlling sources. San Francisco Bay RWQCB staff has estimated the following relative mass discharges of CDDs/CDFs to San Francisco Bay: (1) storm runoff, 67%; (2) air deposition to water, 31%; (3) sewage treatment plants, 2%; and (4) refineries, 0.05%. If aerial deposition is not taken into consideration, the staff estimates that storm runoff accounts for 98% of this CDD/CDF input to the Bay. These estimates are preliminary, and more data must be gathered to refine the percentages.

III. ALTERNATIVES FOR SWRCB CONSIDERATION

Alternative 1. No action. This alternative could result in the RWQCBs implementing the draft CTR criteria for 2,3,7,8-TCDD for only one of the dioxins congeners. Further, the criteria for inland water and enclosed bays and estuaries would be less stringent than the water quality objective for ocean waters for two reasons: (1) the objective would not apply to all 2,3,7,8-TCDD congeners, and (2) a lower fish consumption rate was used to calculate the criteria. These lower water quality criteria could pose a problem for dischargers discharging to inland surface waters or, more particularly, to enclosed bays or estuaries if they had to ensure not only that their effluent meets the requirements of the immediate receiving water body, but also that their effluent quality would not cause or contribute to a violation of the water quality objective downstream in the ocean.

This alternative is inconsistent with the precedent set by the Ocean Plan, in that the CTR criteria will set a lower level of protection of human health because a lower fish consumption value is used (i.e., 6.5 g/day compared with 23 g/day for the Ocean Plan); however, the RWQCBs have the option of adopting effluent limitations more stringent than required by the criteria if (1) they have substantial evidence that more stringent effluent and receiving water limits are necessary to protect beneficial uses, or (2) to ensure that downstream receiving

water standards are met. Such permit limits could be based in part on a regional fish consumption rate. Also, criteria the CTR implemented for 2,3,7,8-TCDD alone does not consider the toxic effects of the other congeners. However, this alternative would be the easiest for dischargers to meet.

Alternative 2. Implement the CTR criteria for 2,3,7,8-TCDD as TCDD equivalents. Under this alternative, the CTR criteria would be applied to all of the 17 CDD and CDF congeners chlorinated at the 2, 3, 7, and 8 positions. This application of the CTR criteria would be consistent with the Ocean Plan water quality objective for TCDD equivalents. Interpretation of the CTR 2,3,7,8-TCDD criteria as equivalents is supported by the structural-activity relationship, relative toxicity, additivity of the congeners, and common practice. Like Alternative 1, this alternative is inconsistent with the precedent set by the Ocean Plan, in that the CTR criteria will set a lower level of protection of human health because a lower fish consumption value is used.

Overall, this alternative is consistent with the goal of SWRCB to first implement the CTR criteria and then, in Phase 2 of ISWP/EBEP, to adopt water quality objectives for priority pollutants. It is anticipated that the revised TEFs and the appropriate fish consumption rates would be available and could be considered at that time.

Alternative 3. Adopt a water quality objective for 2,3,7,8-TCDD equivalents. Under this alternative, the CTR criteria for 2,3,7,8-TCDD would be adopted as TCDD equivalents objectives, adjusted to incorporate a California-specific fish consumption rate. This approach would be consistent with the Ocean Plan. Because selection of an appropriate fish consumption rate affects more than one pollutant covered in the CTR and the TEFs for the congeners are being reassessed, it is appropriate to defer this issue to Phase 2 of the ISWP/EBEP.

Alternative 4. Implement the CTR criteria for 2,3,7,8-TCDD as 2,3,7,8-TCDD only, and require monitoring of the other 16 congeners by NPDES dischargers and, as appropriate, other dischargers. Under this alternative, effluent limitations based on the CTR criteria for 2,3,7,8-TCDD would be established in WDRs if reasonable potential is determined. For the other 16 congeners, the RWQCB would adopt an order to amend the monitoring provisions of NPDES permits (and non-NPDES permits, if appropriate) to require that dischargers monitor the ambient receiving water and discharged effluent. The purpose of the monitoring would be to assess the presence and amounts of the congeners being discharged to inland surface waters, enclosed bays, and estuaries in the State. With these goals in mind, the RWQCB would specify, in the permits, the locations (the receiving water upstream and downstream of the discharge, and the discharged effluent) and frequencies (monthly for majors, semiannually for minors) of the monitoring to be conducted.

Where the monitoring shows that the sum of the concentrations of the congeners, multiplied by their respective TEFs, exceeds the 2,3,7,8-TCDD criteria, the RWQCB would require the discharger to investigate the sources of these pollutants (e.g., to the wastewater treatment system) and potential means of control. The discharger would be required to submit the results of the monitoring, assessment, identification of sources, and potential means of control in technical reports to the RWQCB and the SWRCB within one year after discovery of the exceedance.

This alternative would defer implementation of the 2,3,7,8-TCDD criteria as 2,3,7,8-TCDD equivalents for inland surface waters, enclosed bays, and estuaries due to the following reasons: (1) the WHO Working Group's recommendation to revise some of the TEFs is not yet final and the group's technical document that supports the revisions is not yet available to the public; (2) the WHO Working Group is also addressing CDD and CDF TEFs for fish and birds, and for 12 "dioxin-like" PCBs; (3) the U.S. EPA's dioxin reassessment is not yet available; (4) the OEHHA's reassessment of fish consumption rates, which will be considered in the development of State-adopted objectives, is not yet available; and (5) the SWRCB intends to adopt its own water quality objectives for dioxins, and possibly dioxin-like compounds, in Phase 2 of ISWP/EBEP development, and items (1)-(4) are important to that process. Furthermore, because the congeners appear to be ubiquitous, and the sources and control measures are uncertain, monitoring during the interim period would provide information needed to appropriately address this issue in Phase 2. The technical reports submitted by dischargers would be considered by the SWRCB in establishing water quality objectives for 2,3,7,8-TCDD and other congeners in Phase 2 of ISWP/EBEP development. While the SWRCB continues to support the validity of the TCDD equivalents objective in the current Ocean Plan, it will reassess that objective in light of the results of the Phase 2 process.

IV. STAFF RECOMMENDATION

Adopt Alternative 4.